



# NRI research highlights

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## Quantitative Traits: Keys to Agricultural Productivity

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**M**ost of the traits important to agriculture are quantitatively inherited. In other words, they are shaped by a number of different genes that interact with each other and the environment.

Yield, flavor, and stress adaptation, including drought and salinity tolerance, are examples of economically important traits that can be called quantitative.

In the past 20 years, research has made it possible to identify the specific genetic loci called quantitative trait loci – or QTL's – that are responsible for quantitative traits.

With support from USDA's National Research Initiative (NRI) Competitive Grants Program, researchers at Cornell University are applying genetic and molecular techniques to identify QTL's from wild germplasm that can improve crop productivity.

While this research has been largely confined to tomatoes, the discoveries are relevant to understanding quantitative traits and germplasm diversity in other crops.

### NEW STRATEGIES

The researchers set about developing new methods for finding useful QTL's from wild or unadapted germplasm. Using a molecular genetic map of tomato, they "searched" the genome of wild relatives of tomato for QTL's useful to agriculture.

They developed an approach referred to as "Advanced Backcross QTL Analysis," which allows a direct look within the genome of wild species for particular QTL's. In many instances, the presence of these useful QTL's could not have been predicted based on the phenotype or outward appearance of the wild germplasm.

During the course of this research, the

THE FIGURE REPRESENTS A MAJOR STEP IN THE TRANSITION FROM SMALL-FRUITED WILD TOMATOES TO LARGE-FRUITED DOMESTICATED TYPES.



*...wild germplasm contains a vast reservoir of quantitative trait loci that can be used to increase both crop plant diversity and productivity.*

genomes of 5 wild tomato species were screened, and about 150 new QTL's from wild tomato germplasm that impact one or more traits important to tomato production were identified.

The majority of the QTL's retained their effects when reinserted into germplasm. It has been possible to create commercial tomato varieties that exceed or outperform the originals by 10-40 percent for the desired traits.

These results suggest that wild germplasm contains a vast reservoir of quantitative trait loci that can be used to increase both crop plant diversity and productivity.

## **MOLECULAR BASIS**

Despite its importance to breeding and basic biology, very little is known about the molecular basis of quantitative genetic variation and how QTL's affect the appearance and performance of a plant.

Researchers selected a subset of the QTL's discovered in wild germplasm and set about to understand their function, at both the whole plant and molecular levels. They focused on QTL's for two traits – fruit size and shape – that have been

dramatically modified by domestication and breeding and have a major impact on tomato quality and yield.

The researchers showed that the gene responsible for this transition belongs to a previously unknown class of genes controlling plant development. The gene can be reinserted into a plant to cause the expected QTL effect.

Finally, they demonstrated that the gene causing the QTL effect that is responsible for fruit size changes is expressed early in flower development. This suggests that fruit size and, hence, yield is predetermined by early events in plant development.

## **IMPACT**

This study represents the first time a QTL has been cloned and reinserted into an organism to recreate the QTL effect. This is a significant step in plant biology.

In the future, QTL cloning will be essential for clarifying many aspects of plant biology to improve the genetic performance of crop species. This technology has the potential for increasing crop yields and production efficiency.

The research reported in this factsheet was sponsored by the Plant Genome Program of the Plants Division of the National Research Initiative Competitive Grants Program. To be placed on the mailing list for this publication or to receive additional information, please contact the NRI (202/401-5022 or [NRICGP@reeusda.gov](mailto:NRICGP@reeusda.gov)). The factsheet also is accessible via the NRI section of the Cooperative State Research, Education, and Extension Service website (<http://www.reeusda.gov/nri>).

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